



SECTION III

HAZARDS ANALYSIS

A. BACKGROUND

In order to minimize loss of life, human suffering, damage to public and private property, and economic loss we must have complete knowledge of the types of hazards that affect Hillsborough County. This Hazard Identification and Vulnerability Assessment is a vital component in the development of a county-wide Local

Mitigation Strategy. Through the information gathered, we are better able to determine and prioritize mitigation initiatives.

The Hazards Analysis includes types of hazards, location, and population affected. The information was compiled by Hillsborough County Emergency Management, county and municipal planning departments, the Tampa Bay Regional Planning Council, Port Authority Tampa, National Weather Service, State of Florida DOT, U.S. Geological Survey, National Climatic Data Center, Local Mitigation Strategy Workgroup, and other sources.

Consistent with Federal and State Plans and the County Comprehensive Emergency Management Plan (CEMP), the Hillsborough County LMS reflects an “All-Hazards” approach to mitigation. Therefore, the LMS Work Group researched technological and societal hazards, as well as natural hazards, that may confront the county.

Between 1989 and 2003, the United States suffered an unprecedented number of large-scale disasters, including the tragic events of September 11, 2001, the most destructive hurricane occurring in South Florida (Andrew, 1992); flooding in the Midwest, Georgia, and Texas; a massive winter storm on the east coast; earthquakes in California; hurricanes in North and South Carolina, Florida, Louisiana, Hawaii, and the Virgin Islands; wildfires in Florida and California; volcanic eruptions in Alaska and Hawaii; terrorist attacks in New York and Oklahoma; and many local civil unrest events. The purpose of this LMS is the development of a multi-jurisdictional approach to minimize the risks associated with the hazards faced by the community.

The following table was created to give an overview of the probability, potential impact, frequency and distribution of the hazards which could affect the county. The Plan addresses those natural hazards required by FEMA and the State of Florida. Three of those hazards do not pose any significant threat to Hillsborough County based on historical occurrences and meteorological, geological and topological research. However, due to the specific vulnerability of the County to certain technological and societal hazards, five additional hazards were addressed including hazardous material incidents (both transportation and fixed facility), dam or levee failure, power failure and terrorism.

Table 13
Hazards Vulnerability Analysis Matrix

Hazard – Natural	Probability	Impact	Frequency	Distribution
Coastal /Riverine Erosion	Moderate	Minor	5-10 years	Primarily coastal areas in Tampa and unincorporated county (see Map 9)
Hurricane/Tropical Storm - Minor	High	Moderate	2 years	Storm surge in coastal areas in Tampa and unincorporated county. (See Map 7) Winds - County-wide
Hurricane/Tropical Storm - Major	Moderate	Major	50 years	County-wide and Regional wind damage, coastal and Riverine flooding (See Map 7)
Severe Storm/ Lightning, Hail, Wind	High	Minor	Several a year	Localized - specific to event
Severe Storm/ Tornado	High	Major	2-3 a year	Localized – specific to event
Drought/Extreme Heat	Low	Minor, damage primarily in agriculture	5-10 years	County-wide
Earthquake	None	Major	N/A	N/A
Flooding	Moderate	Minor	5-10 years	Localized (See Map 9)
Winter Storm/Freezes	Low	Moderate, damage primarily in agriculture	3 -4 years	County-wide
Landslide	None	None	N/A	N/A
Sinkholes	Moderate	Minor	Several a year	Localized (See Map 11)
Tsunami	None	None	N/A	N/A
Volcano	None	None	N/A	N/A
Wildfire	High	Minor	Several a year	Localized on Urban Fringe (See Map 13)

Hazard – Natural	Probability	Impact	Frequency	Distribution
Hazard - Technological	Vulnerability	Impact	Frequency	Distribution
Hazardous Materials Transportation	High	Moderate	50-100 a year	Localized, greatest threat along Interstate
Hazardous Materials Fixed Facility	High	Major	5-10 years	Localized, greatest threat at the Port of Tampa
Dam/Levee Failure	Low	Minor	Unknown	Localized, along Hillsborough River
Power Failure Major	High	Moderate, greatest impact in downtowns and urban centers	Unknown	Localized, specific to event
Terrorism	Moderate	Major	Unknown	Localized, specific to event

B. NATURAL HAZARDS

Severe weather events will occur in the Bay area. The tropical climate that attracts people from all over the world to live, work and visit here, also includes sporadic tropical storms, tornadoes and flooding events. And, while the County rarely deals with snow, sleet or ice, winter storms and freezes can significantly impact the agricultural industry and coastal communities.

While these events should come as no surprise, the development within coastal and riverine areas has put both residents and property at risk. The purpose of the LMS planning process is to identify these hazards and cost-effective mitigation strategies to reduce the risk to our community.

Below is a table which quantifies historical losses from the major natural hazards in Hillsborough County.

Table 14
Severe Weather Occurrences
1950-1998

Event	#	Deaths	Injuries	Property Damage	Crop Damage
Hurricanes and Tropical Storms	7	0	4	\$53,821,000	\$15,025,000
Flooding	39	1	1	\$12,925,000	\$401,000
Thunderstorm/Wind	70	1	9	\$2,531,000	\$0
Tornadoes/Waterspouts	105	1	57	\$17,927,000	\$0
Lightning	21	2	17	\$482,000	\$0
Hail	40	0	0	\$200,215	\$15,000,000
Freeze	3	0	0	\$8,000,000	\$47,000,000

Event	#	Deaths	Injuries	Property Damage	Crop Damage
Fog	17	1	30	\$850,000	\$0
Other (rip currents/heavy rain)	2	2	0	\$0	\$0
Total	304	8	118	\$96,736,215	\$77,426,000

Source: City of Tampa, 1999

1. Coastal and Riverine Erosion

Background: In Hillsborough County, erosion along Tampa Bay and river shorelines is most noticeable after a significant rain and/or tidal surge event. In general, erosion is the horizontal displacement of soil. Although this is a natural effect, shoreline development is at risk when erosion occurs at a rate greater than the natural rate of soil replenishment.

Risk Assessment: Areas of greatest risks of erosion were identified within the applicable Local Government Comprehensive Plans as Coastal High Hazard Areas. These areas are found along the Hillsborough, Alafia, Little Manatee Rivers, associated tributaries, and areas illustrated as being within the velocity zones on the Federal Insurance Rate Maps. Erosion principally affects structures through deteriorating the structural integrity of buildings by undermining the foundation or associated pilings/piers.

Probability: Erosion rates and occurrences vary by area and with time. Based on historical trends, coastal erosion occurs every 5-10 years.

Consequences: While erosion itself is not an imminent threat to public safety it does impact the quality of life through damage to buildings, roads/bridges, and infrastructure (lifeline systems). Because of the relationship of flooding to erosion, the same structures affected by one are affected by the other. A worst-case scenario would be a pounding of the coastline from a category 3, 4, or 5 hurricane that was motionless or moving at a very slow forward speed on a parallel line to the west coast of Florida. Past events, i.e. Hurricane Elena, have caused significant erosion at certain locations. While Elena remained more than 80 miles offshore, it resulted in property damage, transportation impacts (causeways) and economic impacts at the Port.

Mitigation: While the County has miles of coastline, a large majority of the developed coastal shoreline has been hardened by seawalls. The seawalls, while not an environmentally preferred mitigation option, do minimize erosion from minor to moderate flooding events.

Strategies to protect the more pristine coastal areas of the community against erosion include: acquisition of sensitive coastal areas through either the county-wide Environmental Lands Acquisition Preservation Program or various state programs such as Florida Forever; adherence to current engineering standards, vegetation and setbacks.

2. Hurricanes and Tropical Storms

Background: Historically, hurricanes are the natural disasters that pose the greatest threat to Florida and Hillsborough County. They have caused the greatest amount of

property damage and as more people move to Hillsborough County, and more development takes place, the potential for hurricane-related deaths and damages, increases each year.

Hillsborough County has experienced the effects (wind damage, flooding, etc) from a number of hurricanes since 1886. The last major hurricane to make landfall was in 1921. A total of five hurricanes have affected Hillsborough County within the last 13 years. They were Hurricane Elena, Hurricane Erin, Hurricane Opal, Hurricane Earl, and Hurricane Georges.

Probability: Based on the history of hurricane affecting the Tampa Bay area, Hillsborough County can expect a hurricane to affect us at least once every 2.6 years. It is considered that the occurrence of a hurricane in the Tampa Bay area on an annual basis is high.

The coastal regions of the United States are associated with intense winds from tropical storms and thunderstorms. It is not uncommon to have winds exceed 100 mph within these areas. Florida, including Tampa Bay, is susceptible to winds of greater than 100 mph on a regular basis. According to data from the American National Standards Institute -- 1982, the Tampa Bay area is identified as having winds in excess of 100 mph return at an annual probability of 0.2% (a 50 year storm event). The probability is greater for an occurrence of a storm with 70 mph winds.

Risk Assessment: Florida has had approximately 287 tropical storms directly or indirectly impacting its shorelines over the last 100 years with approximately 10 affecting the Tampa Bay area. (Multi-hazard Identification, FEMA, 1997).

The vulnerability of Hillsborough County to potential hazards from hurricanes is analyzed prior to each storm. The population at risk and potential for property/economic damages is based on the specific characteristics of the threatening hurricane.

The principle tool for analyzing the expected hazards from potential hurricanes that may affect the Tampa Bay Region is the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) numerical storm surge model. The SLOSH model predicts the tidal surge heights that result from test data about hypothetical hurricanes with various combinations of pressure, size, forward speed, track and winds.

Hurricane Hazards:

The three major hazards produced by a hurricane are the storm surge, high winds and rainfall.

Storm Surge: The storm surge is by far the most dangerous of the three hazards, historically causing nine out of ten hurricane related deaths. This surge, when coupled with the breaking waves, will cause great destruction. The more intense the hurricane, and the closer to perpendicular its track is, in relation to the coastline, the higher the storm surge and resulting destruction will be. Also impacting on the height of storm surge is the depth of the water along a threatened coastline. Because of the configuration of Tampa Bay and the high shoaling factor (shallow water and gradual slope of the Gulf bottom) off the central west coast of Florida, Hillsborough County will receive higher surges than those indicated in the generalized Saffir/Simpson Hurricane Scale.

Table 15
Saffir/Simpson Hurricane Scale

Storm Category	Pressure (inches)	Wind Speed (MPH)	Storm Surge (National avg.) in feet	Potential Storm Surge (SLOSH) in feet	Damage Index
1	> 28.94	74 – 95	4 – 5	7	Minimal
2	28.50 – 28.91	96 – 110	6 – 8	13	Moderate
3	27.91 – 28.47	111 – 130	9 – 12	18	Extensive
4	27.17 – 27.88	131 – 155	12 – 18	22	Extreme
5	< 27.17	> 155	> 18	28	Catastrophic

Source: National Weather Service and Tampa Bay Regional Planning Council, 2000.

Using the 2003 Hurricane Evacuation Zones, some of the major commercial, industrial, and residential areas impacted would include:

- Category 1 storm: Rocky Point; the western, southern, and eastern edges of the Interbay Peninsula including portions of MacDill Air Force Base; Davis Island; Harbour Island; Hookers Point; Port Sutton; Riverview; Gibsonton; Big Bend; Apollo Beach; Ruskin; and portions of the Hillsborough, Alafia, and Little Manatee Rivers floodplain.
- Category 3 storm: Same as a Category 1 storm; portions of Town N' Country; the Westshore business district including a portion of the western-most runway of Tampa International Airport; two-thirds of the Interbay Peninsula including all of MacDill Air Force Base; the eastern and western sides of the Hillsborough River to the Dam including Downtown Tampa and the University of Tampa; Ybor City south of 7th Avenue; portions of the Alafia River floodplain eastward to Lithia-Pinecrest Road; and areas to the west of U.S. 41 south of Palm River.
- Category 5 storm: Same as a Category 3 storm; expanded portions of Town N' Country; the three runways and portion of the terminal, Tampa International Airport; all of the Interbay Peninsula south of Henderson Avenue; area between Hillsborough Avenue and the U.S. 301/I-75 interchange; area east of the By-pass Canal, south of 7th Avenue, and north of the Crosstown Expressway; areas between U.S. 41 and I-75; and expanded areas of the Hillsborough, Alafia, and Little Manatee River floodplains.

Table 16
Developed Parcels by Hurricane Evacuation Zone
Potential Damage to the Number of Structures

Type of Development	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Residential	17,200	20,554	18,765	16,871	12,677
Commercial	821	1,029	1,090	1,703	1,048
Industrial	452	456	448	449	292
Agricultural	212	105	234	168	113
Institutional	148	236	208	285	205
Governmental	454	236	330	521	316
Assessed Value	\$3.8 billion	\$3.2 billion	\$2.4 billion	\$2.5 billion	\$1.5 billion

Source: Hillsborough County Hazard Mitigation Section and the City of Tampa, GIS CD 99-2 entered from the Hillsborough County Property Appraisers Database. 1999.

High Winds: High winds will also render segments of the population vulnerable to the passing hurricane. Throughout Hillsborough County, the approximately 56,000 mobile and manufactured homes will be unable to withstand hurricane force winds. High winds will also have an impact on the timing of the evacuation order, since they arrive at the coastline several hours before the eye of the storm makes landfall. All evacuation activities must be completed prior to the arrival of sustained gale force winds (40 mph with significantly higher gusts).

Rainfall: Since the structure of every hurricane is unique, there is no way to determine the rate and distribution of the expected six to twelve inches of rainfall generally accompanying the storm. However, it is known that the rainfall has only a minor influence on the storm surge water levels. Rainfall, in itself, will not normally require the emergency evacuation of large numbers of residents during the passage of a hurricane as does the storm surge. However, rain may cause the slowing of traffic and may sever evacuation routes which could severely reduce the number of hours available for the overall evacuation.

Maximum Threat: The worst case scenario for Hillsborough County is a Category 5 Hurricane heading northeast at less than 15 miles per hour that makes landfall at high tide near Madeira Beach in Pinellas County. A potential 28 foot storm surge in the back bay areas would inundate the County several miles inland while the winds would destroy thousands of homes and cause damage to thousands more.

Mitigation Approaches: There is a multitude of approaches to mitigate effects from hurricanes. The following illustrates mitigation initiatives that have been the most effective within the region and throughout the U.S.

- *Public awareness and evacuation plans* -- The loss of life due to hurricanes has been reduced due to warning and forecast advances, public awareness programs and the development of evacuation plans. Evacuation efforts and the knowledge of the evacuation process assist in moving residents from areas vulnerable to storm surge, historically the major hurricane “killer”.

However, local officials recognize that public education is key to the success of any response plan especially in the densely population metropolitan communities such as Tampa Bay.

- *Building construction* -- Mitigation of property damage has been most successful in areas specifically designated special flood hazard areas through the implementation of construction codes, land-development regulations and growth management policies
- *Special flood hazard area setbacks* -- Land-development regulations developed in response to the county and cities participation in the National Flood Insurance Program have ensured structures constructed within the previous 20 years are elevated above flood levels and can withstand potential wave action. In addition, the implementation of Comprehensive Plan policies and the creation of a local Environmental Protection Commission have further minimized flooding impacts.
- Development prior to the adoption of various mitigation policies and regulations remains more susceptible to damage. Public education programs have been initiated to assist businesses and residents learn about retrofitting techniques. Mitigation strategies have also included repetitive loss acquisitions, structural elevations, wind retrofit projects, critical facility retrofits and acquisition of designated conservation areas.

3. Severe Storms (Lightning, Hail Storms, Wind, etc.)

Background: It has been estimated by FEMA that the nation receives approximately 100,000 thunderstorms annually with approximately 10 identified as being classified as severe. Florida leads the country with the number of thunderstorms; however, Florida's thunderstorms are shorter in duration than thunderstorms that develop over western states (Arizona, Utah, and Nevada). Thunderstorms in Florida routinely last approximately 30 minutes and rarely affect an area greater than 15 miles. However, multiple storms can develop together and act as an integrated system.

Hazardous conditions associated with thunderstorms include tornadoes, lightening, hailstorms, downburst and microburst winds, and flooding. Strong "downbursts" (winds) exist within thunderstorms. These winds are concentrated, straight-line, winds created by falling rain and sinking air that exceed 125 mph. A separate wind phenomenon is the "microburst, which are narrowly-concentrated downdrafts can exceed speeds of 150 mph. Lightening occurs in all thunderstorms and can strike anywhere (air and ground). The air in which lightning passes reaches to temperatures of 50,000° F

Risk Assessment: Florida has the greatest risk of thunderstorms, with the Tampa Bay area being within the area associated with the highest density of lightening strikes within the continental United States (Multi-Hazard Identification and Risk Assessment, FEMA, 1997). In addition to lighting and as noted previously, thunderstorms contain a variety of hazards including downburst, microburst, tornadoes, and localized flooding and flashfloods.

An additional component of a severe thunderstorm is hail. Hailstorms occur in every state, but mostly within the mid-western area of the United States. Hailstorms cause greater than one billion dollars of damage each year. In Florida, hailstorms occur mostly with the more severe thunderstorms, which are prominent from early summer through fall. Although damaging to property and at times life threatening, Florida does not routinely receive hailstones greater than two inches in diameter (National Weather Service, 1994).

Thunderstorms are classified with respect to the potential damage that can occur. A table describing thunderstorm classifications follows.

Table 17
Thunderstorm Classifications

Types Characteristics	Single Cell Storm	Multi-Cell Cluster	Multi-Cell Line (Squall Line)	Super-Cell
Severe Weather Occurs As:	Brief, isolated downburst; small hail; heavy rain; weak tornadoes	Downbursts, moderate size hail; flash floods; weak tornadoes	Downbursts; small-moderate sized hail; occasional flash floods; weak tornadoes	Strong downbursts; large hail; occasional flash floods; weak-violent tornadoes
Severe Event Predictability	Low	Moderate	Moderate	High (Once identified as Super-Cell)
Danger to Public	Low	Moderate	Moderate	Extreme
Danger to Aviation	Low	Moderate to High	Moderate to High	Extreme

Source: National Oceanic and Atmospheric Agency; Compiled by Hillsborough County.

Probability: The probability of a thunderstorm occurring depends on atmospheric and climatic conditions. Information collected by the National Weather Service found that the Tampa Bay has between 100 and 130 storms per year. The principal season for thunderstorms is similar to that associated with hurricanes – warmer tropical climate resulting in unstable air, which is conducive to the development of thunderstorms. Severe thunderstorms can occur at any time (within the Tampa Bay area), but mostly between the period from early summer through late fall.

The greater the number of thunderstorms and/or their duration, the higher the number of lightening and hail occurrences. According to the NOAA National Climatic Data Center, central Florida (including portions of Hillsborough County) has the greatest probability of lightening strikes within the continental United States.

Consequences: Thunderstorms produce deadly and damaging tornadoes, hailstorms, intense downburst, and microburst winds. Additionally, lightening

causes wildfires and damage to property. Between 1959 and 1993, lightning caused more than 150 deaths within the State of Florida.

Damages associated with thunderstorms range from aircraft disasters to millions of dollars of damage from strong winds (including tornadoes), wildfires created by lightning, flash or localized flooding, and hail. They can also result in deaths, primarily as a result of lightning strikes.

Mitigation: *Warning systems.* There has been modernization of weather observation equipment, which has been linked to early severe-storm warning systems. Within Hillsborough County, more than 800 such connections have been made (Emergency Operations Center, 1999). Additionally, this access has been made available to all residents and businesses through a purchase of a weather radio (available at retail electronic stores).

Severe weather forecasting/detection is employed at the Tampa International Airport to detect conditions favorable for micro-wind bursts or wind downburst and reduce the chance of aircraft accidents due to “wind sheer”.

Techniques for reducing damage by lightning exist and have been incorporated into building standards. Some of these techniques include grounding various electrical components to lead the lightning away from a structure. Power surge protectors including “whole house protection” are also promoted by utilities to minimize damage.

4. Severe Winds/Tornadoes

Background: Severe winds are a major cause of fatalities and property loss in the United States. The two principal sources of wind-related loss of life and property damage are tornadoes and hurricanes. Tornadoes, which affect almost every state, are more frequent and result in greater property damage in the central United States. Winds associated with hurricanes affect most coastal states and territories.

The U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) estimated approximately \$14 million dollars in damage from severe wind events between 1987 and 1996 within Hillsborough County. The damage was the result of 22 tornadoes and 112 downbursts. These occurrences resulted in one death and 16 injuries. NOAA identifies damaging winds as occurring in two categories: rotational (tornadic) or straight-line (downburst). Both forms of wind are bi-products of a thunderstorm and can cause a similar degree of damage. Tornado wind damage is often highly concentrated over narrow width in relation to their damage length. Downburst wind damage is normally spread out over a broader width but shorter damage length. In either case, both can cause substantial damage to structures.

Table 18

Damaging Wind Occurrences 1987-1996				
From a Thunderstorm Event	#	Dth	Inj	Property Damage
Downburst	112	0	12	\$10,000,000
Tornadoes	22	1	4	\$4,000,000

Source: National Climate Data Center Severe Weather Events Database, Letter from Mr. Zaleski, Jr., 1996; Hillsborough County, 1999.

Tornadoes materialize at the trailing edge of large frontal cyclones that result from the clash of high pressure and low pressure weather systems moving at continental scales across North America. Because of climatic differences, southern states like Florida experience their most violent tornadoes in winter. A tornado event is not limited to winter. They can also be generated during the summer in association with afternoon thunderstorms. Most tornadoes are of short duration and do not touch down as the Category 4 or 5 that make national headlines.

Risk Assessment: Severe thunderstorm/wind events occur on the average of 1-2 every year in the Tampa-Hillsborough County area with sufficient force as to cause damage (City of Tampa, 1999). Additionally, wind damage is also a major concern as hurricanes approach the Gulf Coast of Florida.

Thunderstorms spawn more than 1,000 tornadoes annually. Over the last two decades, there have been more than 106 federally declared disasters due to tornado damage. Although Florida has between 50 and 100 tornadoes annually, it is not considered as being within "Tornado Alley."

The National Weather Service ranks the Tampa Bay area as one of the highest areas in Florida for the occurrence of tornadoes. One of the most deadly tornado events in central Florida history occurred on October 3, 1992 when four people died and more than \$100 million in property damage occurred.

Since 1950, the National Climate Data Center has recorded 142 tornadoes in Hillsborough County. These tornadoes resulted in three deaths, 129 injuries, and \$24 million dollars in property damage. A table presenting these reported tornado events in the county between 1987 and 1996 follows.

Research conducted by the City of Tampa Planning staff found that the majority of tornadoes (51%) that have struck Hillsborough County between 1950-1988 had wind speeds of 73 miles per hour or less. A few of these tornadoes had wind speeds of more than 113 miles per hour, the equivalent of a Category 3 hurricane.

Probability: Florida has averaged approximately 75 tornadoes per year since 1950, with an average of three deaths and 60 injured per year. According to the

National Climatic Data Center, the state of Florida experienced 3,983 tornado events from 1950 through February of 2003.

In terms of where tornadoes are most likely to occur, the northern portion of the state's Gulf Coast, between Tampa and Tallahassee, along with the Panhandle region have generally experienced more tornadoes. This is primarily due to the high frequency of thunderstorms making their way east through the Gulf of Mexico.

It should be noted that during severe storms, multiple tornadoes can form. Thus, using probabilities of tornadoes based on the total number of tornadoes reported may be somewhat higher than by using the number of storms in which a tornado(s) formed.

As storm events with wind speeds ranging from 40 mph to greater than 318 mph, tornadoes can be expected to inflict a considerable amount of damage over a wide area. Consequently, tornadoes generate a tremendous amount of debris, which becomes airborne creating additional damage to other structures. Because of extreme winds and the amount of airborne material generated, people living in manufactured or mobile homes are most exposed to damage from a tornado. Additionally, pillared and/or unanchored businesses and residential units are at greater risk of damage from a tornado as well.

Table 19
Tornado Events in Hillsborough County
National Climate Data Center Severe Storm Data, 1987 - 1996.

Date	Time	City /Place	Length (Miles)	Width (Feet)	Deaths	Injured	Rating	Damage Scale (1-9)
8/88	19:02	Tampa	1.0	90			1	5
6/90	13:15	Plant City	0.1	15			0	0
7/90	18:00	Sun City Center	0.1	15			0	4
4/91	14:35	McDill AFB	0.6	120			0	3
4/91	15:00	Temple Terrace	1.0	180			1	5
10/92	11:20	13 NW Tampa	2.0	750		2	1	4
10/92	16:00	NW Hills. Co.	0.1	15			0	0
1/93	14:00	Citrus Park	0.1	15			0	4
3/93	00:30	Tampa	0.1	15			0	5

Date	Time	City /Place	Length (Miles)	Width (Feet)	Deaths	Injured	Rating	Damage Scale (1-9)
6/94	16:00	Tampa	0.1	15			0	0
6/94	21:50	Tampa	1.0	90			1	5
6/94	21:20	Tampa	0.1	15			0	0
7/94	17:10	Tampa	0.1	15			0	6
6/95	18:03	Valrico	0.1	15			0	0
8/95	10:47	Tampa	0.1	15			0	0
11/95	20:55	Tampa	1.2	150		2	0	4
10/96	11:58	Tampa	20.0	15			0	unknown
10/96	13:45	Plant City	11.0	15			0	unknown
10/96	14:04	Plant City	6.0	15			0	unknown
10/96	14:00	Tampa	0.3	15			0	unknown
10/96	21:35	Tampa	0.3	15			0	unknown
10/96	14:58	Riverview	2.0	250	1		2	unknown
Total					1	4		

Source: National Weather Service; Storm Data Publication, 1996 Tornado Statistics; 1999

The following observation from the LMS profile for Florida, is particularly relevant to Hillsborough County, especially considering the county’s anticipated continued growth, particularly in the easternmost unincorporated areas:

There have been many tornadoes in Florida that could have killed scores of people and caused millions of dollars in property damage, but most of these tornadoes did not hit heavily populated areas. The most deadly tornado event in the state’s history occurred on February 22 and 23, 1998 in which 45 people were killed. As the state’s population continues to increase, particularly in the interior part of the state, the threat of a devastating tornado event grows.

Mitigation: The techniques used to mitigate the destruction caused by tornadoes are similar to those used for other wind hazards. The potential of extreme damage from a severe tornado will, however, make it difficult to mitigate in a cost-effective manner. The best protection from a tornado is provided by the type of construction and the reinforcement of walls, floors, and ceilings. Proper anchoring of walls to foundations and roofs to walls is essential for a building to withstand certain wind speeds (Residential Retrofitting, FEMA, 1997).

Additionally, there has been modernization of weather observation equipment and its linkage to early severe-storm warning systems.

The National Oceanic and Atmospheric Agency has produced standards to assist in reducing the risks associated with tornadoes. These include:

- Improve radio and wire communications with the media,
- Educate the public regarding the “safe room”,
- Equip gathering places with weather radios with an audible alert of warning,
- Continue awareness and preparation efforts in schools, and
- Make special efforts to inform mobile home residents.

The Hillsborough County Emergency Operations Center has implemented the aforementioned programs.

5. Floods

Background: Floods can occur in most communities in the United States. Flooding can result from the overflow of major rivers and their smaller tributaries, storm surge from hurricanes and other coastal storms, or inadequate local drainage. Historically, floods have been a factor in over 80 percent of all Presidential-declared disasters. The Nation's strategy for reducing flood damages has evolved from a reliance almost solely on structural flood control projects to a more comprehensive approach that emphasizes non-structural measures such as local land-use planning and zoning, building codes, and acquisition or relocation of flood prone buildings.

The importance of a sound flood management policy is evident when it is considered that flooding and water related damage account for 80 percent of Federal disaster declarations.

The National Flood Insurance Program (NFIP) has played a critical role in fostering and accelerating this change. NFIP was established by the National Flood Insurance Act of 1968, which makes federally backed flood insurance available in those states and communities that agree to adopt and enforce floodplain management measures that meet or exceed minimum Federal criteria. NFIP was broadened and modified by the Flood Disaster Protection Act of 1973, which requires the purchase of flood insurance as a condition of receiving any form of Federal or federally related financial assistance. The National Flood Insurance Reform Act of 1994, strengthened NFIP by providing for mitigation insurance and establishing a grant program for State and community flood mitigation planning and projects.

Forty percent (40%) of the total flood insurance policies are within Florida, with 60% of flood claims being made through the State (Regional Office, FEMA, 1999). In Hillsborough County there are nearly 40,000 structures with coverage in excess of \$4.9 billion. A table listing this information by jurisdiction follows. Of the 700,000 structures in the County, FEMA has identified 400 as having received flooding.

Table 20
Insurance Premiums and Policies by Jurisdiction

Jurisdiction	Premiums Paid	Total # Policies	Coverage Total
Unincorporated	\$9,418,000	22,740	\$2,730,681,600
Plant City	\$56,000	133	\$16,433,300
Tampa	\$8,240,000	16,300	\$2,136,925,100
Temple Terrace	\$76,000	232	\$33,105,600
County Totals	\$17,790,000	39,405	\$4,917,145,600

Source: Federal Insurance Agency, 1998; Compiled by Hillsborough County, 1999.

The National Flood Insurance Act of 1968 also requires that the President develop a Unified National Program for Floodplain Management. In 1994, a report on this program was provided by the Federal Interagency Floodplain Management Task Force. The update includes a set of national goals for floodplain management to focus the efforts of all levels of government as well as the private sector. In addition, Executive Order 11988, Floodplain Management, issued in 1977, requires that Federal agencies undertake a planning process prior to taking actions in, or that impact on, floodplains. The Midwest Floods of 1993 resulted in a further evolution in Federal flood policy. There is now a new emphasis on the acquisition or relocation of flood-damaged properties using funding from a number of Federal programs and from state and local governments and the private sector.

Risk Assessment: The type of flooding events that have occurred within Hillsborough County includes: inland, riverine, local drainage and high groundwater, fluctuating lake levels, and tidal surge.

- Inland flooding is a localized event associated with heavy rainfall and is usually occurring in areas identified as being within the 100-year floodplain or along recognizable drainage channels.
- Riverine flooding occurs following heavy rainfall events over an extended period of time. Areas in the county susceptible to this kind of flooding can be found along the Alafia and Little Manatee Rivers.
- Drainage/stormwater flooding usually occurs following a heavy rainfall event over a relatively short period of time. This type of flooding is usually localized to urban areas.
- Tidal flooding is the result of the effects of wind and low pressure in coastal areas. The effects are exacerbated when combined with high tide.
- Fluctuating lake levels is associated with either large weather systems and/or a continuous rainy season.

Probability: Flooding varies within the county. It has been determined that structures that are within the 100-year flood elevation have a 26% chance of being flooding in any given year. The actual risk of flooding varies on the height of the “finished floor” elevation. Because of the varied background associated with construction within the county, some structures flood at a two year interval (a severe flooding problem).

The occurrence of flooding in Hillsborough County between 1950 and 1998 has been documented and quantified. The data, however, does not provide an indication of the cause of the flooding. The information does show that the Tampa-Hillsborough area may have a major flood event on the average of once a year. A table listing the flooding events from 1950 to 1998 follows.

Table 21

Flooding Events in Tampa-Hillsborough County 1950-1998				
Type	#	Deaths	Injuries	Property Damage
Flood	4	1	1	\$7,150,000
Riverine	21	0	0	\$5,220,000
Urban/Small Stream Flood	14	0	0	\$555,000
Total	39	1	1	\$12,925,000

Source: National Climate Data Center Severe Weather Events Database

FEMA has quantified the probability of flooding through the preparation of Flood Insurance Rate Maps under NFIP. Made available to all jurisdictions, these maps delineate the 100-year floodplain. In using the maps, it is important to note that it is probable that no one storm will inundate all the areas within the flood zone and that areas outside the identified 100-year floodplain may be flooded.

Typically, monthly rainfalls in Hillsborough County range between 1.15 inches for April to as high as 7.61 inches for August. It is not unusual for individual, heavy rainfall events to occur. Between 1995 and 1998, there were five instances when the amount of rainfall exceeded 3.5 inches in a 24-hour period. Based on historical patterns, Hillsborough County can expect to receive 1-2 such downpours each year.

Principal areas most susceptible to flooding in a 100-year event include: the western and southern portions of the Interbay Peninsula, Davis Island, Harbour Island, Hookers' Point and port areas of Tampa, unincorporated areas of Odessa and Ruskin, and the floodplains of the Hillsborough, Alafia, and the Little Manatee Rivers.

Consequences: For those residents of Hillsborough County who live along the coast, the Hillsborough, Alafia, and Little Manatee River, within the 100-year floodplain, or urban neighborhoods, living with the flooding is a way of life. While

the chances of flooding are not a common event, should it occur, the consequences can range from annoying to catastrophic.

Although improvements have and will be made, floods will continue to occur. The amount of flooding should be reduced as drainage improvements are made and homes built prior to the County's implementation of the National Flood Insurance Program are upgraded/ removed. As Hillsborough County continues to grow, the issue of flood protection becomes evermore complicated. These factors include the affects on new development downstream, the increased amount of impervious surfaces and loss of natural water storage areas.

Mitigation: Warnings of potential flooding, or an actual flood, is the responsibility of the National Weather Service (NWS) and the Florida Division of Emergency Management (DEM). Warning time for flood events may vary significantly. The least warning time would be with severe thunderstorms, which occur frequently in our area, but give little notice as to the extent of rainfall that can be produce in various parts of the County. With regard to riverine flooding as little as 4-6 hours of warning are possible. An average warning time for coastal flooding would be about 12 - 18 hours, however certain systems could produce more or less warning time.

In addition to warnings and public notification, there are other measures of protecting against floods. With the exception of Plant City, the remaining jurisdictions in Hillsborough County participate in the National Flood Insurance Program (NFIP). Through this participation, standards exist for mitigation development in areas designated as flooding.

Through the NFIP, development regulations have been approved that assist in ensuring new development is designed and constructed in a fashion that is more flood-resistant and out of the 100-year floodplain.

6. Winter Storms/Freezes

Background: Severe winter storms can affect the Tampa Bay area. Although Hillsborough County is not affected by snow, significant freezes have occurred with significant impact to the agriculture industry. Winter storms may be accompanied by other hazards, such as coastal flooding, strong winds (tornadoes), wind-chill, and power outages. These effects disrupt commerce, transportation, and may result in the loss of life. The winter "No-Name" storm that affected Tampa Bay in March 1993 is considered one of the worst non-tropical storms in United States history. Equivalent to a Category 2 hurricane, it caused a significant amount of flooding and power outages within the Tampa Bay area and accounted for more than \$2 billion of damage across the eastern United States.

Risk Assessment: Typically, winters are mild with low temperatures ranging around 50 degrees. Freezing temperatures can occur on one to two mornings per year during December through February. In some years no freezing temperatures occur. Snowfall is very rare. Based on the 1951 – 1980 period, the average first occurrence of 32 degrees F in the fall is December 26 and the average last occurrence in the spring is February 3.

As seen in the following table, between January 5, 1999 and January 25, 2003, Hillsborough County experienced 19 temperature extremes; 17 freezes and two wind-chill.

Probability: The probability of a damaging freeze in any given year is considered low to moderate. Based upon historical trends, it is expected that Hillsborough County will receive a damaging freeze, on an average, approximately once every three to four years.

Consequences: Although the possibility of a major freeze in Hillsborough County is considered rare, they have occurred with devastating consequences. Since 1960, the County has experienced three such events: 1962, 1977, and 1983. The latter two resulted in over \$163 million in agricultural losses. In addition to the immediate economic impact of these freezes, a secondary impact was its contributing effect of the abandonment of many citrus groves and their conversion to urban uses.

Table 22
Economic Loss from Recent Freeze Events

Date	Type	Damage	
		Property	Crop
01/05/1999	Freeze	\$200,000	\$475,000
01/26/2000	Freeze	0	0
02/05/2000	Freeze	0	0
11/22/2000	Freeze	0	0
12/20/2000	Freeze	0	0
12/20/2000	Freeze	0	\$1,000,000
12/30,2000	Freeze	0	\$4,500,000
01/01/2001	Freeze	0	\$5,100,000
01/04/2001	Freeze	0	0
01/05/2001	Freeze	0	\$6,900,000
01/07/2001	Freeze	0	0
01/10/2001	Freeze	0	\$4,00,000
01/21,2001	Freeze	0	0
01/04/2002	Freeze	0	0
01/04/2002	Freeze	0	0
01/09/2002	Freeze	0	0
02/28/2002	Freeze	0	0
01/23/2003	Wind-chill	0	\$8,500,000
01/25/2003	Wind-chill	0	\$8,500,000
Totals		\$200,000	\$38,925,000
Source: National Climatic Data Center, October 2003			

Mitigation: Techniques to mitigate the destruction caused by freezes are similar to measures used for other severe-storm hazards. Additionally, there has been modernization of weather observation equipment, which has been linked to early severe-storm warning systems.

To assist with power that may accompany a severe freeze, utility companies and the Hillsborough County Emergency Operation Center have developed a “Response Plan for Power Shortage Emergencies Caused by Extreme Weather Conditions.” The Plan identifies strategies to minimize power outages due to severe weather (either through equipment failures or greater than peak usage of power) and to ensure “critical facilities” operations are maintained.

7. Droughts / Heat Wave

Background: Drought is a normal phenomenon of all climates. The technical identification is a water shortage caused by a deficiency of rainfall. Additionally, a drought can be aggravated by other factors, such as high temperatures, high winds, and low humidity. The severity of drought depends on a multitude of factors, which include duration, intensity, geographic extent, water supply of the region, and demands by the local community on the existing water supply. The Federal Emergency Management Agency has identified four types of droughts: meteorological, hydrologic, agriculture, and socioeconomic.

Risk Assessment: The risks associated with droughts are both social and economic. On the social side, there is the impact on available potable water resources and the subsequent need to take corrective measures. On the economic side, there is the impact on agriculture and those businesses which depend on water such as landscaping and recreation. Representing a combination of both social and economic risk is the short and long-term environmental impacts of a drought.

Probability: There are no common techniques determining the return of a drought event. For Hillsborough County and the Tampa Bay region as a whole, droughts are becoming a common event. The area has experienced several drought events over the last ten years. The National Drought Mitigation Center indicates that the last began in March 2000 and did not end until 2003.

Consequences: In addition to a drought’s social and economic risks described above, there is also the potential increase in the formation of sinkholes.

Mitigation: Preplanning is the key to drought mitigation. Measures must be considered to both increase available water supplies and improve the efficient use of those supplies.

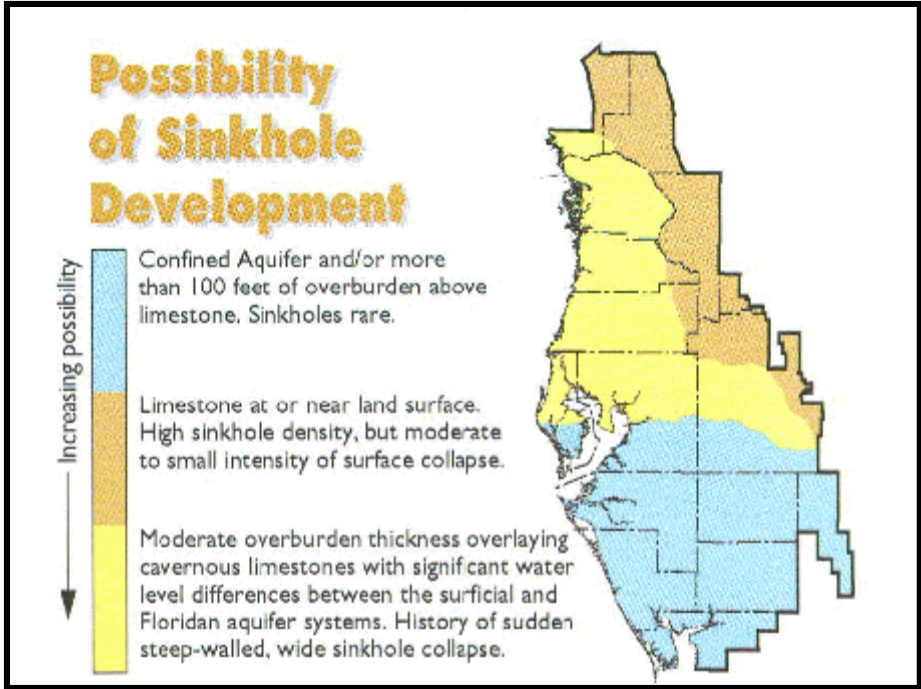
The Tampa Bay area lies within the Southwest Florida Water Management District. The District has developed a water management plan that is implemented during time of droughts to minimize their adverse effects. Additionally, the area’s potable water supply is provided by Tampa Bay Water. These two agencies work closely with local governments to ensure mitigation strategies are implemented during a time of drought.

8. Sinkholes / Landslides

Background: For the residents of Florida, the sudden appearance of sinkholes is not an unusual occurrence. The potential magnitude of these occurrences are exemplified by the creation of Paynes Prairie at Gainesville, the loss of the

automobile repair facility in downtown Winter Park and the recent de-watering of Lake Jackson north of Tallahassee. Fortunately, most sinkholes are not of the size of these examples. Even so, the destruction resulting from even the smallest sinkhole cannot be underestimated.

Figure 3



Taken from an Issue Paper, the Southwest Florida Water Management District (SWFWMD) noted that sinkholes are “as common in Florida as lakes, rivers and warm weather. In fact, many lakes in central Florida were formed by sinkholes.” As the name suggests, sinkholes result from the ground “sinking” and creating a depression. The cause of the depression is underground in the porous limestone base. As rainfall is filtered through the ground to the limestone, it erodes and dissolves the soluble rock and creating cavities in the subsurface. Another cause of sinkholes is the lowering of underground water levels, either by lack of rainfall or over pumping for water supply. In this case, the water in the underground cavities helps support the layers holding up the land surface.

Risk Assessment: Within the 17 counties which comprise SWFWMD, sinkholes develop more frequently north of Tampa Bay where the limestone base is closest to the land surface and the supporting sand and clay layers are thin. The following graphic identifies the increasing possibility of sinkhole activity with SWFWMD.

As seen in the graphic, using the Alafia River as a reference point, Hillsborough County is roughly divided in half in terms of the possibility of sinkhole formation. North of the Alafia River, sinkhole formation increases in possibility whereas

south of the river, sinkhole formation is rare. These are validated by the fact that SWFWMD has recorded 300 sinkholes in Hillsborough County since 1970. Of these, 290 occurred north of the Alafia River and 10 south of the river.

The primary risk associated with sinkholes is the collapse of a structure due to the ground giving way underneath. Such occurrences are normally not widespread, but they can totally engulf and destroy individual structures.

Probability: The difficulty in emergency planning for sinkholes is the fact of not knowing exactly where and when they will occur. Geologists have a good idea where sinkholes are likely to form geographically, but it's much more difficult to accurately predict specifically where sinkholes will occur. As a consequence, while the damage could range from low to high, it is almost impossible to predetermine in Hillsborough County which individual property could be affected by sinkhole activity. All that be ascertained with any certainty is that the likelihood of sinkholes will occur in that portion of the County located north of the Alafia River.

Consequences: Sinkholes generally do not cause tremendous damage since their average size is generally small, less than 10 feet in width. Structural cracks, sagging floors, or large potholes in yards or roadways will usually occur due to a sinkhole collapse.

The greatest threat to the general population and overall public welfare would result when a sinkhole occurred at a site containing hazardous materials. If severely damaged by a sinkhole, chemicals could be released causing severe health risks to nearby residents. There is also a potential risk that a sinkhole, disrupting a facility's foundation, might cause hazardous materials to enter the underground water system.

Mitigation: It is difficult to determine where and when a sinkhole will occur. It is possible to detect sinkholes in the early stages of development. Sites can be examined for the sinkhole activity through ground penetrating radar. Once found, preventative measures can be undertaken, such as filling the void, to prevent a collapse of land from occurring. In general, such measures can be costly and are limited to projects that would be significantly impacted financially as a result of a sinkhole.

For residential homes, sinkhole damages are covered by homeowner's insurance. In such cases, a residential homeowner may not be willing to invest in costly mitigation measures (which may not necessarily ensure a structure's survivability), when in reality the annual insurance premiums already cover the potential risk. Because sinkhole occurrences are few, this may be the most effective form of mitigation for homeowners.

9. Wild Fires

Background: As people search for a place to live, they often desire two conflicting conditions: Live in the country but have urban services readily available. This desire for urban/rural living has been given the name "wildland/urban interface." As described by the Florida Division of Forestry, the

wildland/urban interface “refers to that geographical point where two diverse systems – wildland and urban – meet and affect each other and give rise to conflicts between societal values and expectations concerning the management of natural resources.” The major problem resulting from the wildland/urban interface is wildfire.

Nationally, since 1970, wildfires have destroyed 10,000 homes and 20,000 other structures, cost \$20 billion to suppress, and \$6 billion in restitution. Wildfires in Florida are not an unusual occurrence. From 1981 to 1996, there was an average of 6,080 wildfires each year, burning 219,725 acres. According to the State, since 1998, there have been more than 21,000 wildfires, devastating over 1.3 million acres, and destroying more than 1,000 structures. The largest and costliest wildfires in Florida history occurred in May 2001. The Mallory Swamp fire near Perry burned 57,000 acres and cost an estimated \$6.7 million to suppress.

Risk Assessment: As the population of unincorporated Hillsborough County continues to grow, the number of residents residing within the wildland/urban interface also grows. The University of Florida’s Institute of Food and Agricultural Science has identified the fire characteristics of nine ecosystems found in Florida’s wildland/urban interface.

Table 23
Ecosystems in Florida’s Wildland

Ecosystem	Fire Frequency (years)	Wildfire Hazard
Scrub Pine	10 – 100	Extreme
Pine Rockland	3 – 10	Extreme
Pine Flatwood	1 – 8	Extreme
Dry Prairie	1 – 4	High
Marsh	1 – 5	High
High Pine/Sandhill	1 – 8	Medium
Swamp	5 – 200	Medium
Hardwood Hammock	30 – 50+	Low
Hardwood Rockland/Tropical Hammock	59+	Low

Three of these ecosystems can be found in Hillsborough County: Pine Flatwood, High Pine/Sandhill, and Swamp.

Probability: While the conditions which are favorable for wildfires are well known, where and when they will occur cannot be predicted. The three principal ingredients for wildfires are topography, fuel, and weather. According to the Florida Division of Forestry, Florida is unique in that weather and topography are different from other parts of the country. Here we have relatively flat terrain and abundant rainfall. These factors normally afford firefighters an opportunity to control interface fires in a timely and effective manner. When rainfall is below normal or a killing frost has decimated vegetation or vegetation is allowed to accumulate, the likelihood for a wildfire increases.

According to the State, Florida's typical fire season is from January through May. The potential for wildfires increases dramatically during the dry season as a result of low humidity and high winds. The largest number of lightning caused wildfires occurs in July coinciding with the peak of the thunderstorm season. The top three causes for wildfires in Florida, as determined by the Florida Division of Forestry are arson/incendiary, escaped debris burning, and lightning.

Consequences: The consequences of a wildland/urban interface wildfire were described by the Florida Division of Forestry as follows:

"Today, most people's dream home is a place tucked in among the trees with a view of a lake or stream. A place where they can get away from it all; a place that is secure; serene and most of all quiet. Unfortunately, these places...come at a cost, the very real danger of wildfires....Wildfire often begins with little or no warning, spreading quickly, igniting trees, brush and your home."

In addition to homes, wildfires can also damage/destroy commercial structures, public infrastructure, and agricultural activities. In other words, their impact can be far ranging.

Mitigation: The logical method for mitigating the threat of wildland/urban interface wildfires would be to stop development from occurring in the interface. Of course, this will not occur.

One method for mitigating for the dangers of wildfires would be through the application of the development principals outlined through the Firewise Communities program. The concepts of this program include: establishment of defensible space; fire-resistant attachments, preparation of a disaster plan; lean, clean, and green landscaping, fire-resistant roof construction; fire-resistant roof construction; and emergency access.

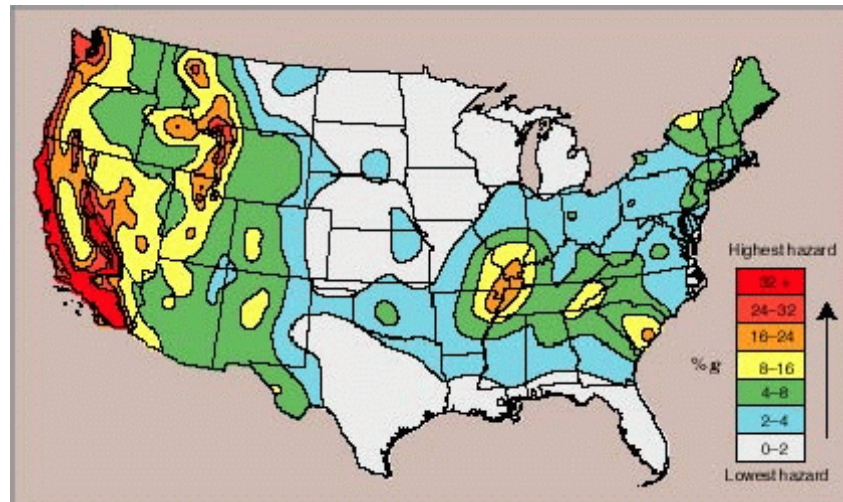
For Hillsborough County, a second mitigation measure would be the continued implementation and enforcement of the Hillsborough County Emergency Management's wildfire preparedness guidelines.

10. Earthquakes

Background: Earthquakes tend to occur in region's near the boundaries of underground plates or at weaknesses in the plates themselves. According to Douglas Smith of the University of Florida Geology Department, "Florida does not include any plate boundaries, and the plate the state occupies is very stable. 'There are no recent volcanoes and there are no known active faults in Florida.'" Smith noted that the largest earthquake ever recorded in Florida shook the state on January 12, 1879. At 11:45 p.m., two 30-second tremors occurred, possibility centered in the Palatka area. The 1992 Florida Atlas reports that in 1905, an earthquake, with its epicenter in west-central Manatee County, was recorded. This earthquake registered a I using the Modified Mercalli intensity scale (where VII equates to maximum damage) meaning that there was little to no damage reported at the surface.

Probably: In an article by Anthony Randazzo and Douglas Smith, University of Florida Geology Department, it was noted that Florida is one of the few low-risk areas for earthquakes in the continental United States. The conclusion is verified by the following 2002 USGS map of seismic hazard probability.

Figure 4
Earthquake Vulnerability Map



Although many historical events have been reported as earthquakes in Florida, and some descriptions conclusively suggest actual earthquakes, no damaging events are known to have occurred within the state.” In this regard, the authors noted that reported earthquakes could be the law enforcement officials destroying confiscated explosives or, when atmospheric conditions are right, the vibrations of military jets breaking the sound barrier.

Risk Assessment: In terms of vulnerability, Dr. Smith stated that “a region of north Florida bounded roughly by Jackson County in the west, Nassau County in the east, and Volusia and Levy counties in the south appears slightly more likely to experience earthquakes than other parts of the state.” Randazzo and Smith concluded their article by noting that the “continued monitoring and documentation of the seismic activity of the Florida Plateau, however small, is essential to the development of the long term seismic characterization of the state.”

Mitigation: Due to the extremely low possibility of an earthquake occurring in Hillsborough County, there is little need for mitigation measures.

11. Tsunamis

Background: When a person hears the term “tsunamis” odds are that they’ll think of a large wall of water resulting from a major earthquake somewhere in the Pacific Ocean. The unfortunate truth is that such a belief is only partially correct. While tsunamis can be very large, they can also be only a few meters tall. Tsunamis may be generated by any event which results in the vertical displacement of the water column. Although generally associated with

earthquakes, tsunamis may also be caused by underwater landslides, volcanic eruptions, explosions, and even the impact of cosmic bodies, such as meteorites.

Probability: Since tsunamis generally result from earthquakes, it is not surprising that they would occur most frequently occur along the boundaries of tectonic plates as found along the continental Pacific coast, Alaska, and Hawaii. This assumption may not be totally true, however. In an article entitled “Tsunamis and Tsunami-Like Waves of the Eastern United States” (Science of Tsunami Hazards, Volume 20, 2002) it was noted that since 1600, “40 tsunamis and tsunami-like waves...have occurred in the eastern United States.” The Atlantic coast of Florida was included among those areas feeling the effects of a tsunami.

According to some scientists, certain submarine conditions exist which increase the likelihood of the east coast of the United States experiencing a major tsunami. This belief is not shared by all, however. Tom Hilde of Texas A & M University notes in an article entitled “Tidal Waves Not Likely In Atlantic” that “most of the world’s tsunamis are generated at convergent plate margins....the Atlantic margin of the United States is a passive margin, not a plate boundary, and so is not tectonically active. This area has few, and generally low magnitude, earthquakes...” Even so, some scientist, such as George Maul, professor of oceanography at Florida Tech, has noted that “it’s not a matter of if; it’s a matter of when” the Atlantic will experience a tsunami. In a “Florida Today” article, it was noted that “although tsunamis are rare in Florida and the Caribbean, geologists say the threat is real.”

Risk Assessment: Since Florida is not located along the convergent margins of the tectonic plates, there is no likelihood of earthquake-generated tsunamis. While history has shown that Florida’s east coast has experienced some tsunami activity, there is no such record for the Gulf coast. Consequently, it can be assumed that the Gulf coast has little to fear from this natural occurrence.

Consequences: With their power and little warning, a tsunami has the potential to be destructive both in terms of property damage and loss of life. Of equal concern should be danger posed by a rouge wave. Rouge waves are sudden, extreme waves with wave height well above the background waves. The generally occur in rough sea conditions. A rogue wave, estimated to be 18 feet tall, hit Daytona Beach on July 3, 1992. It is believed that this particular wave was the result of a series of thunderstorms off the Georgia coast.

Mitigation: As noted above, the likelihood of a tsunamis affecting Florida is slight. Even so, the possibility of a tsunami affecting the eastern coast of Florida is real. Consequently, emergency management professionals should remain on alert to those events which may result in a tsunami.

12. Volcanoes

Background: Throughout history, volcanoes have inspired and awed mankind. At the same time, history speaks to us of the awesomeness and ability of volcanoes to destroy and create. Probably no greater example of the power of the contrasting personality can be found than the destruction of Pompeii and

Herculaneum by Mount Vesuvius and the creation of the Hawaiian Islands by Mauna Loa and Kilauea.

The location of volcanoes is not a random occurrence on the earth's surface. Rather, most volcanoes are concentrated in chains on the edges of continents, along island chains, or beneath the sea. The USGS states that these volcanic chains "are closely related to the way in which [the] Earth's crust is divided into more than a dozen enormous section or plates and how the plates move relative to one another according to the theory of plate tectonics." Interestingly, more than half of the world's active volcanoes above sea level encircle the Pacific Ocean forming the "Ring of Fire."

Probability: In addition to the Hawaiian Islands, the greatest probability of volcano activity in the United States is found along the Cascade Range and in Alaska. Not surprisingly, this area represents the boundary between the Pacific and Continental plates. According to the USGS, predicting the time and size of volcanic eruptions remains a difficult challenge for scientists.

Risk Assessment: The nearest volcanic activity to Florida occurs in the islands of the Caribbean basin. Since Florida is not located near a plate boundary, there is no probability of volcanic activity.

Mitigation: No mitigation measures need to be considered.

C. TECHNOLOGICAL HAZARDS

1. Hazardous Materials

Background: Manmade hazards often referred to as technological hazards, can occur in all areas of society. There are approximately 6,774 hazardous materials events in the U.S. annually. Of these, the greatest risk of an event is associated with the transportation system (FEMA, 1997).

Table 24
National Annual Hazardous Materials Events

Average Annual Occurrences	6,774
Percent Transportation	80%
Percent Railroad	15%
Percent Other	5%

Source: Federal Emergency Management Agency, 1997; Hillsborough County Emergency Management Operations and Hazard Mitigation Agencies, 1999.

The majority of the transportation hazardous materials events involve tanker trucks or trailers and certain types of bulk-cargo vehicles. Because of the number of miles traveled by these vehicles within the County daily, transportation is the

greatest area of potential hazardous materials spills. Additionally, rain, high winds and fires can worsen conditions surrounding these hazardous materials events.

Risk Assessment: There are a wide variety of facility sites within the county which use or store hazardous materials. Accurate data are not available to make a determination as to the magnitude of potential hazards. In addition, hazardous materials releases result from storage tank and container ruptures or leaks, releases through safety and relief valves, piping ruptures and leaks, fire induced releases, equipment failures, overfills and overflows of storage tanks and human error (FEMA, 1999). Most facilities have taken passive mitigation efforts (i.e., dikes, berms, etc.) to contain liquid spills that might occur. With most extremely hazardous material facilities, receptacles are protected from Florida's worst-case disasters such as hurricanes.

Table 25
Contributing Hazardous Materials Factors – Traffic Accidents
Hillsborough County Only

Number of Industrial Sites	2,954
Licensed Tractor Trailers	8,139

Source: Hillsborough County Tax Collector, 1999; Hillsborough County Property Appraiser's Office, 1999; and Hillsborough County Metropolitan Planning Council; 1998.

Industry has taken great steps to minimize the risk associated with the storage and transportation of hazardous materials. The need for such attention is manifested in the Port of Tampa. The Port of Tampa contains the largest concentration of hazardous materials in Hillsborough County. Included are such products as petroleum, chlorine, and ammonia. Although these products are stored within an industrial area, the port is located immediately adjacent to downtown Tampa and large residential concentrations on Harbour Island and Davis Island.

For the City of Tampa, approximately 25.3% of the recorded incidents are related to a hazardous condition other than residential gas and fuel spill emergencies. Damage estimates associated with the hazardous conditions are not available. All calls for hazardous incidents within the City are funneled through the Tampa Fire Rescue Department.

Table 26

Number of Hazardous Materials Calls - For the City of Tampa 1993-1998			
Hazardous Condition	Number	%	1-year Average
Residential Gas Emergency	714	33.5	143
Hazardous Condition	540	25.3	108
Fuel Spills	879	41.2	176
Total Calls (incidents)	2133	100.0	427
Source: Tampa Fire Rescue Department from records of the number of calls placed to the Department between 1993 -1998			

Probability: Presently, there is no analysis on the probability of a hazardous material release or accident in the port area (Tampa Bay Regional Planning Council, 1999). The Regional Planning Council reports that under the law SARA Title III/Emergency Planning and Community Right-to-Know Act (EPCRA) every Section 302 facility must have a hazard analysis performed and made available for public inspection. The analysis must identify a circle of vulnerability (identifying populations at risk) for the most-probable worst-case release and a most-probable release scenario from the facility. These analyses will not provide a probability of release - only what would happen if a release occurred. This information is used to identify those populations and significant facilities (schools, government buildings, hospitals, etc.) which may be at risk and the mitigation measures that may be used in event of failure. The hazard analyses use a "High, Medium, and Low" probability of risk of release and a "High, Medium, and Low" probability of danger.

Consequences: Hazardous materials releases pose short and long-term toxicological threats to humans and to terrestrial and aquatic plants and wildlife. Toxic materials affect people through inhalation, ingestion, and/or direct contact. As noted previously, should a hazardous material spill or accident occur in the Port of Tampa under favorable weather conditions, a significant number of people working, visiting, or living near the port could be adversely affected

Mitigation: There are two basic types of applications used to avoid hazardous materials events. These are physical and social adjustments. Physical adjustments include:

- Planning and designing facilities to withstand various natural hazards;
- Identifying and avoiding sites where risks are high;
- Predicting occurrence; and
- Preventing or altering the characteristics of the potential hazard.

Social adjustments for avoiding impacts associated with hazards include:

- Restricting use of land and establishing minimum standards and conditions;
- Implementing public awareness programs;
- Initiating emergency preparedness and evacuation programs;
- Establishing systems of notification;
- Spreading economic loss among a larger population through insurance, taxation and monetary grants; and
- Reconstructing communities to be less vulnerable to future hazard events and releases.

Mitigation also involves the continued dialogue between industry and emergency responders.

2. Dam/Levee Failures

Background: When the term "dam" is used, it is normal to think only of structures associated with the impounding of rivers for use as drinking water reservoirs, the production of electricity, or flood control. In Florida, the term can take on an additional meaning, that of impounding clay settling ponds or phosphogypsum

stacks associated with the mining and processing of phosphate. Both types of structures can be found within Hillsborough County.

Located east of 28th Street, just downstream from the City of Temple Terrace, is the City of Tampa's Hillsborough River Reservoir. The Reservoir is approximately 1,300 acres in size and contains up to 1.6 billion gallons of water. The Reservoir has served as the City of Tampa's water source since the mid-1920s.

In southeastern Hillsborough County, near CR 672 and SR 39, south of the Alafia River, is the Tampa Bay Regional Reservoir. The Reservoir is being built by Tampa Bay Water to provide an additional source of potable water for the residents of the Tampa Bay area. When completed in 2004, the 1,100-acre Reservoir will have a total volume of 15 billion gallons.

During the 1950s and 1960s, residents along the Hillsborough River experienced several serious flood events. As a consequence, in the 1960s and 1970s, the Tampa Bypass Canal was constructed. Following the course of Palm River, the 14 mile waterway, with its flood-control structures, is intended to redirect rising waters from the Hillsborough River to McKay Bay. In addition to the Tampa Bypass Canal, flood control structures can be found along several of the creeks in the western portions of Hillsborough County. These creeks flow into the northern reaches of Tampa Bay.

Phosphate mining activities can be found in the eastern portions of the County. As noted above, phosphate mining and processing requires the need for water impoundments associated with clay settling ponds at the mining site and phosphogypsum stacks associated with the phosphate processing plant. Generally, phosphate processing plants are located in proximity to the mine sites. The exception to this is the Cargill Plant located at the mouth of the Alafia River on Hillsborough Bay.

Risk Assessment: The construction and safety of dams and levees in Florida is governed by Chapters 62 and 373, FS. Through design and permitting, there is little danger of failure from the Hillsborough River Reservoir, Tampa Bypass Canal, or Tampa Bay Regional Reservoir.

Unfortunately, the same cannot be said for clay settling ponds and phosphogypsum stacks. Since 1988, there have been four failures of such facilities either in or directly impacting Hillsborough County. The following is a summary of these events:

- 1988 and 1993, Riverview, unincorporated Hillsborough County. Acidic water spill at the Cargill (aka Gardinier) phosphate processing plant located at the mouth of the Alafia River.
- November 1994, Hopewell, unincorporated Hillsborough County. Failure of a clay settling pond at the Hopewell Mine spilled approximately 1.9 million gallons of water into the Alafia River. In addition, some flooding occurred in the Keystone area.

- December 1997, unincorporated Polk County. Failure of a phosphogypsum stack at Mulberry Phosphates resulted in 2.0 million gallons of phosphogypsum process water entering the Alafia River.

Probability: There is not a method of determining the probability of a dam failure or a historical frequency that can be used to calculate a return interval of an earthen dam failure. Working together, the phosphate industry and the State have proven that a dam monitoring program can be successful in minimizing the risk associated with dam failures through periodic inspections and repair programs. Additionally, a failure due to a single rainstorm or tropical storm event is minimal due to the design of a respective dam and the periodic monitoring such areas receive.

Consequences: Residents of Tampa living downstream of the Hillsborough River Reservoir are the most vulnerable should there be a dam failure. The exact number of residents which would be affected by such an event would be dependent upon the degree of the failure.

Concern with flooding was a major issue of residents and elected officials during the permitting of the Tampa Bay Regional Reservoir. The potential for such an event was deemed to be slight during the review of the Reservoir's Environmental Impact Statement by the U.S. Environmental Protection Agency and construction permit by the Florida Department of Environmental Protection.

Although it is possible, is not probable that the failure of a clay settling pond or phosphogypsum stack would adversely impact county residents. This determination can be made based on the general isolated nature of these operations. Still, as noted in the 1994 event, flooding of residences can occur. As a result of their general isolation, it is not possible to determine the potential number of residents in the unincorporated county who could be affected. The major consequence of a failure event would be the resulting environmental damage should contaminated water reached a creek or river or infiltrate into the groundwater supply.

Mitigation: The State and industry have in-place federally approved dam inspection processes (Federal Insurance Agency, 1998). Areas associated with mining have been identified on growth management maps and within the Hillsborough County Comprehensive Plan. Use of these programs and continued cooperation between the County, State, and industry will serve to minimize the risks of dam failures within Hillsborough County.

3. Port Vessel Collision or On-Water Hazardous Materials Spill

Background: In any mishap within the port, there is a need for one focus point to ensure efficient efforts are taken to minimize risk and to ensure an effective response is given. The U.S. Coast Guard is the principal authority at the Port of Tampa with respect to oil spills or vehicle collisions.

Risk Assessment: The Coast Guard has not recorded a major oil spill in the immediate Port of Tampa area. There have been minor spills associated with

industries ancillary to the port itself. It has been observed that the risk of a spill is greater at the transfer of materials at landing areas than en-route.

Probability: As a major port, the probability of an accident involving hazardous materials does exist. However, mitigation measures for in-route transportation are in place to minimize exposure to the general populace and to the environment. Thus, the probability of a serious event is considered to be low.

Consequences: As an active port, two factors are present which contribute to the need for vigilance. First, as a port, hazardous materials will always be present, either in transit or storage. Second, as a port, the potential for accidents is always present, either in the transfer of hazardous materials from ship-to-shore to storage, or transfer from storage to overland transport. Given the amount of hazardous materials found at the port and its location, should a spill or fire/explosion occur the impact on the surrounding community could be catastrophic!

Mitigation: Maintaining safety of port operations is the responsibility of the U.S. Coast Guard's Marine Safety Office. To improve overall safety, this office coordinates its activities with the various governmental agencies of the county, city, and region and industry. This coordination has resulted in several programs being put into place which will improve the overall safety of the port's operation.

In response to the growth of the Port facility, multiple avenues of communications have been obtained and ongoing cross-agency training of personnel has been instituted. In addition, fire-fighting contingency plans have been developed and vessel-response plans have been incorporated to ensure resources are available for operations in the event a major catastrophe should occur.

4. Terrorism / Homeland Security

Background: As the tragic events of September 11th demonstrated, the United States is not exempt from the threat of terrorist attack on its home shore. While the kinds of weapons a terrorist may use are varied, the most fearful are those classified as weapons of mass destruction (WMD). Of these, the greatest threat comes from those classified as NBC or nuclear, biological, and chemical. In addition, terrorist attacks may be as common as explosives and as sophisticated as global cyber-attacks.

Risk Assessment: Conventional wisdom is that obtaining the material to create nuclear weapons remains very difficult. Still, it is possible to obtain sufficient quantities of radioactive material to make what are known as a "dirty bomb." Similarly, the chemical agents or biological agents are relatively difficult to obtain, and more difficult to deliver or disperse in the population. However, they do pose a greater threat than that associated with nuclear material weapons.

Probability: As home to MacDill Air Force Base with Central Command and Special Operations, a major theme park and a major port, Hillsborough County must consider itself a potential terrorist target. In addition, Hillsborough County has a significant agricultural base which may be vulnerable to biological/chemical

contamination as well as serving as the home of many corporate headquarters particularly vulnerable to sabotage and cyber-terrorism.

Consequences: The impact of a single terrorist attack would of course vary depending on the attack. A terrorist attack which is successful could kill or injure a large number of people. There are also potential long-term environmental and/or economic impacts of an attack.

Mitigation: Post 9/11 has placed a greater urgency on the need for vigilance and preparation. Federal, state, and local law enforcement, public safety, and emergency management officials and agencies are working in greater cooperation to coordinate pre-event preparation and potential post-event response.

A renewed interest in Community Emergency Response Teams (CERT) as part of the Citizen Corps has been identified by the LMS Working Group and the community as an invaluable asset in homeland security. (See Resolution supporting the Citizen Corps Council and CERT training)

5. Utility Failure/Power Outages

Background: As growth continues in Hillsborough County, there is an increasing demand for electrical power. Through the 10-year Site Plan process, Tampa Electric Company (TECO) addresses growth in their expansion plans. Still, there may be situations whereby their power generating capability may not meet total demand during extreme weather conditions or after a severe storm.

Probability: It is difficult to predict when a power outage may occur, as the northeast power failure showed in 2003. What can be predicted are the types of situations which may contribute to such an event. This situation was highlighted during the Christmas weekend of 1989 as the extremely cold weather caused extended power outages throughout the county. Although the cold weather scenario is the most likely to result in power shortage emergencies, similar problems may occur during extremely hot weather.

Consequences: Of course a power failure is most likely to occur during an extreme weather event. Local governments must be prepared to respond in order to maintain the public safety and health and welfare of its citizens.

Mitigation:

TECO must actively manage power distribution during shortages. During these periods, one of TECO's power management techniques is to rotate outages among users. There are various facilities in the County that must be highlighted as critical users of TECO power during power shortages.

A committee of representatives from the County, the three municipalities and TECO have developed and categorized a critical facility list for the County. All critical facilities have been placed in priority categories. From this critical facility list TECO has developed a priority circuit network that will be used during any power shortage emergency.

TECO's goal during any future power shortage emergency is to limit power outages to any circuit in the county to a maximum of 15 minutes at a time combined with periods of an hour or more with power functioning.

ATTACHMENT B

Hazard Vulnerability Maps

7. Hurricane Storm Surge Areas
8. Hurricane Evacuation Zones
9. NFIP Flood Zones
10. Flooded Structure Occurrence by Section
11. Sinkhole Distribution
12. Hazardous Material Storage Sites
13. Wildfire Vulnerability
14. Wind Vulnerability

